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GENERAL SCANNING INC.

MAY 1972

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GROUP 250

SERIES G

OPTICAL SCANNERS

359-214

SERIES G
OPTICAL SCANNERS

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general description

General Scanning Optical Scanners are precision instruments specifically designed to deflect mirrors of varying sizes at the fastest possible rates in sinusoidal, sawtooth, triangular wave and stepping motion.

The units feature long life, high stability and repeatability, and large angular excursions. They are small, rugged and efficient. They can be mounted in any orientation. Wobble is typically below 10 arc-seconds. A wide variety of mirror sizes can be accommodated.

A tangent correction is usually provided so that image displacement on a projection plane, rather than mirror rotation, is proportional to drive current. Rated amplitude can be obtained in sinusoidal motion from dc to approximately 140% of the natural frequency.

Typical applications are facsimile transmission, photographic typesetting, laser trimming of microcircuits, infrared scanning, optical tracking, flaw detection, automatic gauging and optical character recognition.

scanner selection guidelines

Scanner size selection is dictated primarily by the inertia of the mirror that is to be driven. To achieve the best possible frequency response, the armature inertia of the scanner selected should lie between 1/3 and 3 times the mirror inertia. Figure 1 shows the natural frequency, as a fraction of the unloaded natural frequency, in terms of the mirror-to-armature inertia ratio. The inertia of idealized mirrors is given in Figure 2.

With the appropriate electrical drive circuits (see bulletin on Optical Scanner Drivers) it is possible to achieve sawtooth and triangular wave scanning at frequencies up to 35% of the natural frequency; and stepping through any angular displacement in half a period of natural oscillation.

All Scanners can be modified for special requirements:

- Bearings can be lubricated with silicone grease for operation in vacuum.
- Stiffness can be varied to provide the highest natural frequency for a particular angle of scan.
- Mirror supporting surface can be made so that it gives a rotational bias to the mirror.

Combinations of these scanners can be mounted into XY Scanning Head Assemblies.

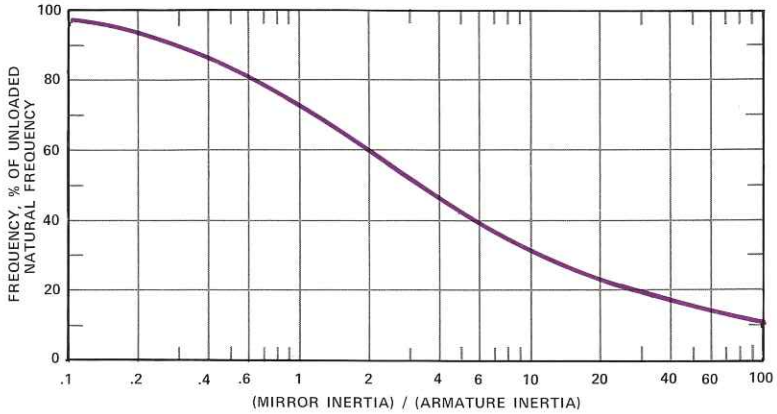

Figure 1. Scanner Natural Frequency versus Mirror Inertia.

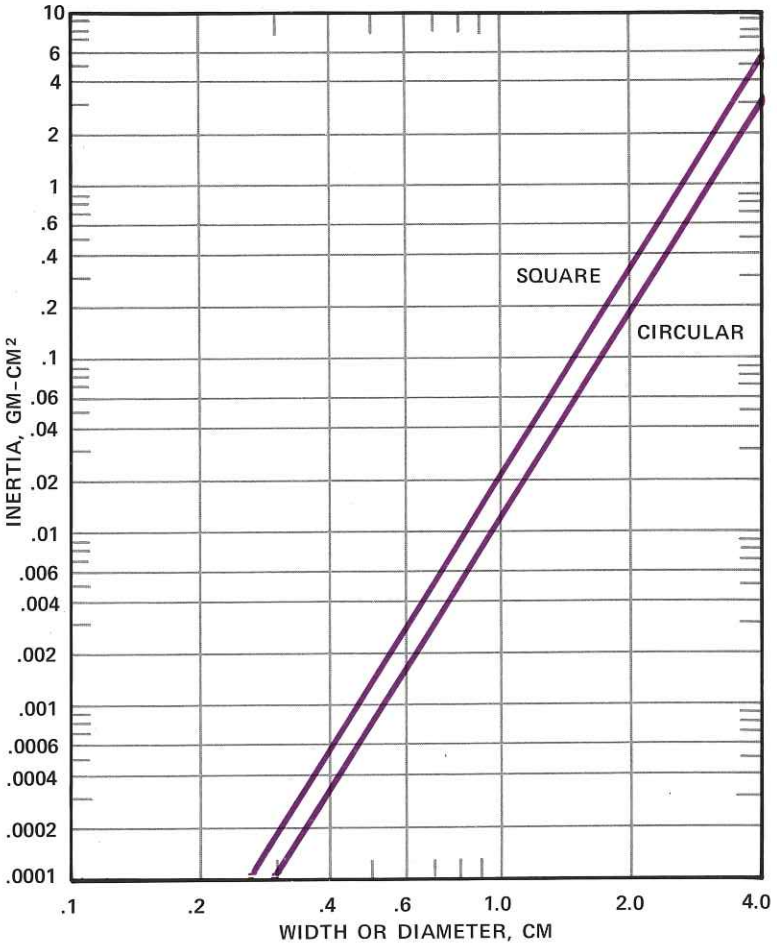

Figure 2. Inertia of Square and Circular Glass (2.46 gm/cc) Mirrors, 1mm Thick (axis of rotation parallel to face and through center of gravity).

XY·ASSEMBLIES

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general description

The General Scanning XY Assemblies are suitable for deflecting a stationary light beam about orthogonal axes or, conversely, for sampling a two-dimensional optical field with a stationary light detector. They consist basically of two galvanometers, with orthogonal axes, so that a light beam incident on the X-axis galvanometer is reflected onto the mirror of the Y-axis galvanometer and then onto a projection plane.

The galvanometers are selected from this Bulletin. Modifications of the basic line can be made to accommodate special requirements.

The optical scanning function provided is shown in Figure 5. The input beam and the undeflected output beam are at 90 degrees to each other. Other orientations can be obtained with the aid of an auxiliary mirror provided.

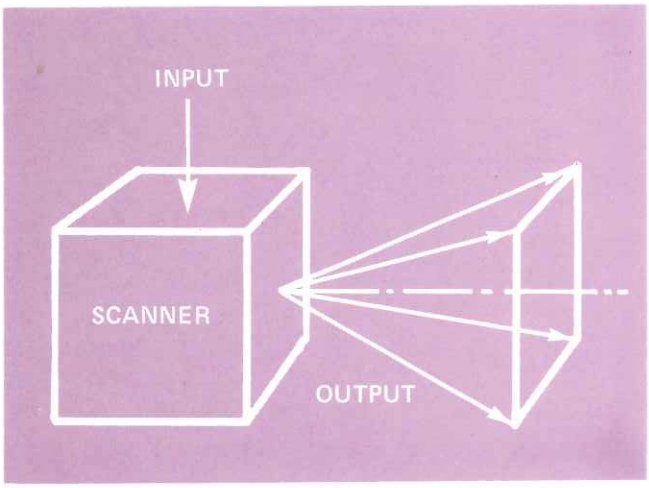

Figure 5. Basic Scanning Function.

optical accuracy

The geometry used is such that no optical distortion is introduced about one axis, and the distortion about the other is minimized and very small. The nature of the distortion is given in Figure 6, which represents the actual projection of a rectangle. The pin-cushion error that occurs is given by:

$$(\epsilon/2p) = (1-\cos\beta) / 2\cos\beta$$

where β is the optical angular deflection in the Y-direction measured from the neutral position. For instance, a scanner with 30° optical peak-to-peak range in the Y-direction will exhibit a pin-cushion error of 1.7%.

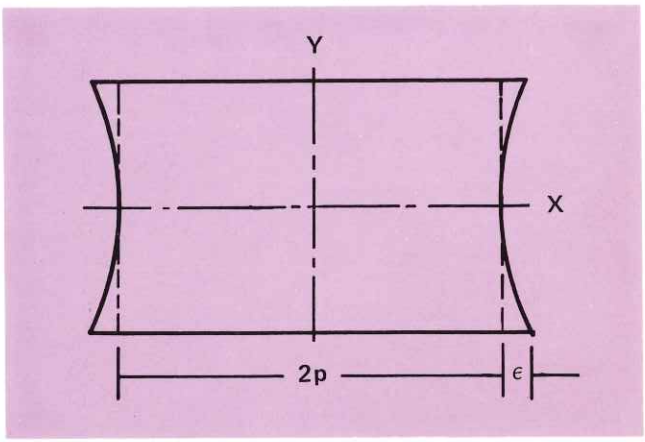

Figure 6. Pin-Cushion Distortion.

mirror sizes required

In the configuration where the input and output beams are orthogonal, the width of the X-mirror (the dimension perpendicular to its axis of rotation) must be at least 1.42 D, and its height at least D, where D is the diameter of the light beam to be deflected.

The width of the Y-mirror must be at least 1.08 D, and its height at least $(D + 2e\tan\alpha)$, where e is the distance between the galvanometer axes and α is the optical angular deflection in the X-direction. Normally, values of e are 0.50 in. for XY Scanners with G-100 galvanometers, and 1.50 in. for XY Scanners with G-300 galvanometers.

Where the diameter of the light beam and/or the optical deflection β desired in the Y-direction are large, it is possible for the X-mirror to interfere with the beam reflected by the Y-galvanometer. The maximum value of D/e that will not result in interference is given as a function of β in Figure 7.

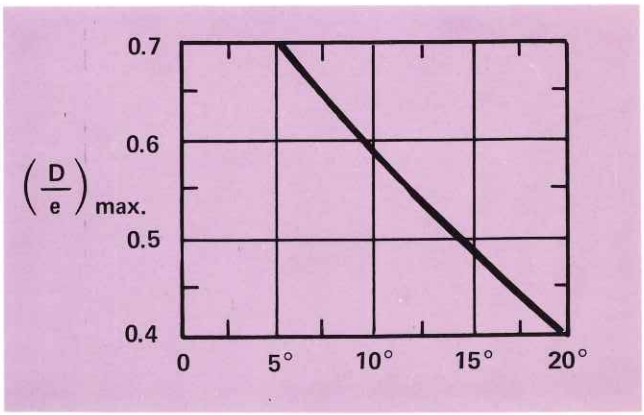

Figure 7. Maximum Usable Aperture.

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stock mirror sizes

These are front surface mirrors, available from stock, for mounting on General Scanning scanners. They are made from flat glass stock, flat to one wavelength per inch, and coated with aluminum and silicon monoxide.

MIRROR DIMENSIONS (First dimension given is perpendicular to axis of rotation; last is thickness)	UNITS	ROTARY INERTIA, gm-cm² Axis through center of gravity	Axis through front surface
3.5 dia. x 0.5	mm	0.000093	0.000100
5.0 dia. x 0.5 *A	mm	0.000382	0.000400
0.50 dia. x 0.030	in.	0.0237	0.0240
1.00 dia. x 0.060	in.	0.804	0.816
0.25 x 0.25 x 0.040 *B	in.	0.0034	0.0037
0.25 x 0.625 x 0.040	in.	0.0086	0.0093
15 x 30 x 3.2	mm	0.69	0.79
1.0 x 1.0 x 0.125	in.	2.77	2.91
1.0 x 2.0 x 0.125	in.	5.54	5.82

*NOTE: A) Standard Mirror Size for G-0606 Scanners.
B) Standard Mirror Size for G-100 Scanners.
Other mirrors may be purchased on special order.
Please consult the factory for a quotation.

electrical drive characteristics

The scanner drive current causes the instantaneous application of a torque to the armature. In tangent-corrected devices, the tangent of the optical deflection produced by the torque is proportional to the current. The voltage E required to produce a given drive current i is given by:

$$E = iR + L\,(di/dt) + B\dot{\theta}$$

where R denotes the resistance of the coil, L its inductance, B the back-emf constant, and $\dot{\theta}$ the rate of rotation in the direction of deflection. Values of these parameters are given in the Specifications. The back-emf can be fed back to damp out unwanted oscillations in transient response. A typical feedback circuit is shown in Figure 3. Damping can also be obtained by assembling the Scanner with internally shorted coils, or by feedback of the derivative of position. To provide the latter, General Scanning makes a line of Scanners with position transducers, which also have greater accuracy (see Data Sheet on Scanners with Position Transducers). The coil configuration of all Scanners is given in Figure 4.

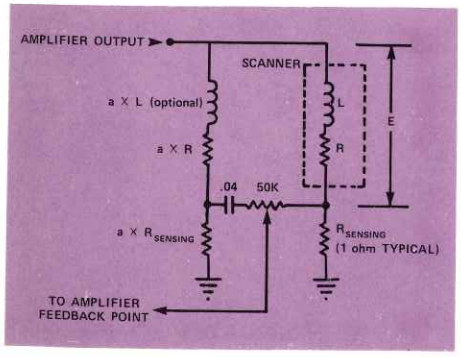


Figure 3. Typical Scanner Feedback Circuit.

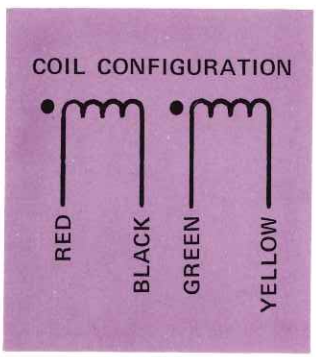


Figure 4. Coil Configuration for all Scanners.

specifications / optical scanners SERIES G

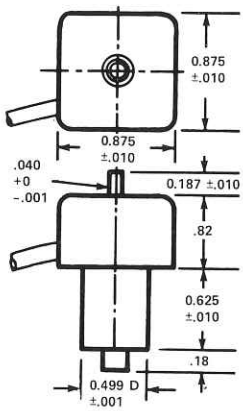
MODEL	G-06
Load-free (no mirror) Natural Frequency, Hz	3,2
Mechanical Rotation, peak-to-peak	6°
Armature Inertia, gm-cm²	0.00
Torque — approx., gm-cm	50
Coil Resistance, ohms ±1 (S=Series, P=Parallel)	6,9
Coil Inductance, mH	2,9
Sensitivity, mA/degree	250
Back-emf constant mv/degree/second	0.1
Temperature Coefficient of Sensitivity	
Linearity	
Repeatability	
Hysteresis, % of peak-to-peak	
Life, cycles	

In G-060 and G-100 scanners, the mirrors are attached with epoxy di
a removable aluminum bracket. Front reflective surface is usually copla

mechanical data SERIES G-060

INPUT CABLE LENGTH • 9 inches
MOUNTING • On 0.499 inch diameter hub
FINISH • Black Anodize
BEARINGS • Unshielded
WEIGHT • 2.5 ounces

All dimensions shown in inches.



INPUT CABL
MOUNTING
FINISH • Bl
BEARINGS •
WEIGHT • 3

G-300S

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G-300

G-200

G-060

G-100

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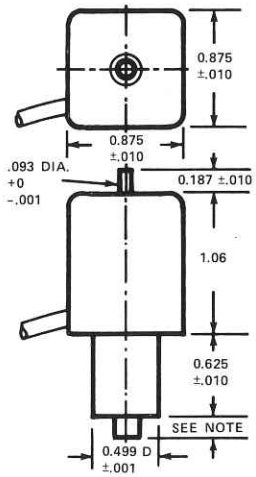
606	G-0612	G-108	G-112	G-115	G-124	G-208	G-215	G-230	G-302	G-306	G-310	G-320	G-330
00	2,100	1,500	1,200	950	700	340	250	155	520	300	230	165	130
	12°	8°	12°	15°	24°	8°	15°	30°	2°	6°	10°	20°	30°
16	0.0019	0.011	0.011	0.015	0.015	1.0	1.0	1.0	3.7	3.7	3.7	3.7	3.7
	50	80	75	75	70	330	330	250	1000	1000	950	850	750
S	6,S	8,S	8,S	8,S	8,S	8,P	8,P	8,P	8,P	8,P	8,P	8,P	8,P
S	2,S	4,S	4,S	4,S	4,S	18,P	18,P	18,P	30,P	30,P	30,P	30,P	30,P
0	125	150	100	80	50	160	85	35	550	170	100	50	35
2	0.12	0.23	0.23	0.23	0.23	0.9	0.9	0.9	2.9	2.9	2.9	2.9	2.9
	+ 0.06% / °C						+ 0.02% / °C						
	1% of peak-to-peak, or better												
	0.05% of peak-to-peak, or better												
	3	0.7											
	10^{11}	10^{10}											

rectly to the output shaft; G-200 and G-300 mirrors are attached with epoxy to
nar with axis of rotation to ±0.020 inches and parallel within ±30 minutes of arc.

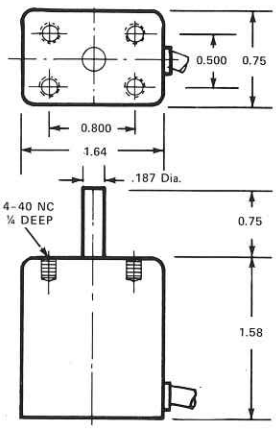
SERIES G-100

LE LENGTH • 9 inches
• On 0.499 inch diameter hub
ack Anodize
• Shielded
3 ounces



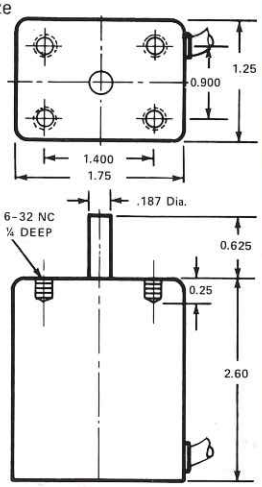
SERIES G-200

INPUT CABLE LENGTH • 9 inches
MOUNTING • 4 front holes, ¼ inch deep on 0.800 inch x 0.500 inch centers tapped 4-40 NC.
FINISH • Black Anodize
BEARINGS • Shielded
WEIGHT • 5.5 ounces



SERIES G-300

INPUT CABLE LENGTH • 9 inches
MOUNTING • 4 front holes, ¼ inch deep on 1.400 inch x 0.900 inch centers tapped 6-32 NC.
FINISH • Black Anodize
BEARINGS • Shielded
WEIGHT • 16 ounces



NOTE • Shaft also available 1.375 inches long.

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mounting arrangements

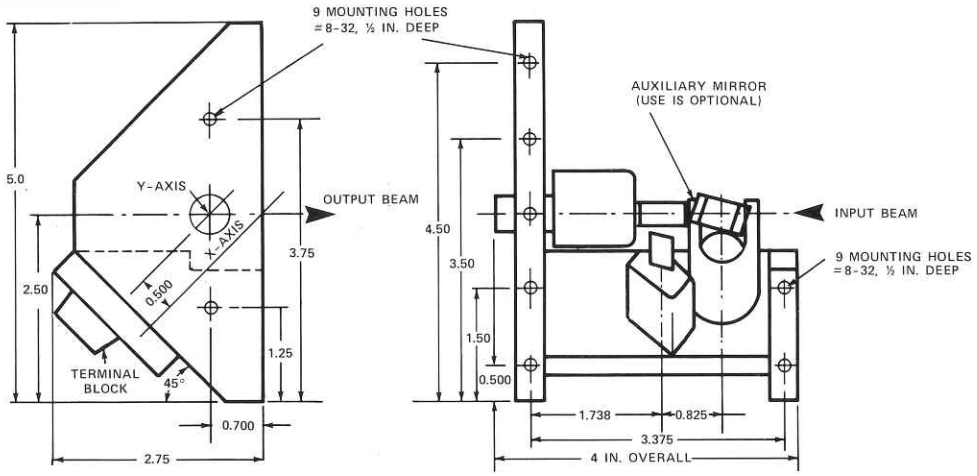
The galvanometers are supported from a rigid, black-anodized aluminum mounting frame, which is provided with several 8-32 threaded ½ in. deep mounting holes. The most accessible mounting surface is a plane perpendicular to the exit beam. The frame is fairly open, and the galvanometers are sufficiently accessible to allow other optical elements such as lenses and filters to be mounted in close proximity.

driver amplifiers

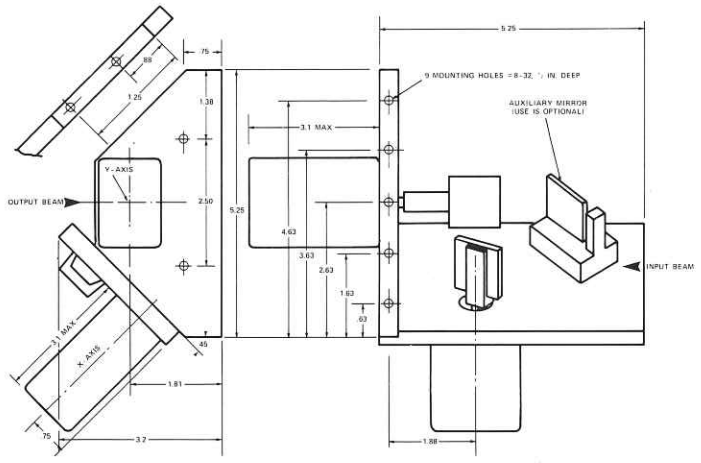
The XY Scanners are normally driven with an AXY-150 Two-Channel Driver Amplifier. They can also be driven with any combination of driver amplifiers. Refer to bulletin: Driver Amplifiers for Series G Scanners.

mechanical data SERIES XY-100

All dimensions shown in inches.



SERIES XY-300



WARRANTY: All General Scanning products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery or in the case of certain components listed in the operating manual, for the time period specified. We will repair or replace components which prove to be defective during the warranty period provided they are returned to General Scanning. (We cannot be held liable for consequential damages.)

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